UNIVERSITI PUTRA MALAYSIA

COLOUR AND OTHER RELATED QUALITY CHARACTERISTICS OF CANNED PINEAPPLE (*ANANAS COMOSUS* L. MERR.) AS AFFECTED BY STORAGE PERIOD AND CANNING MEDIA

JAYASHREE KANNIAH

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By

JAYASHREE KANNIAH

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia. in Fulfillment of Requirements for the Degree of Master of Science

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DEDICATION

This thesis is dedicated to my father who is always giving me his support, mother who is always praying for my well being and my two brothers who will always light up my life.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement of the degree of Master of Science

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Chairman: Associate Professor Siti Hajar Ahamd, Ph.D.

Faculty: Agriculture

The effects of storage period and canning media on canned pineapple (*Ananas comosus* L. Merr.) slices (CPS) were determined. The canned pineapples were stored at ambient temperature for 6 and 12 months with 0 month acting as the control. The pineapple slices were canned in media containing pineapple juice and light and heavy syrup. The CPS studied belonged to grades Standard, Choice and Fancy according to the Malaysian Standard Specifications for Canned Pineapples (MSSCP). The experimental design was a randomized complete block design with a factorial arrangement of treatments (3 storage period x 3 types of canning media), and with three replications. The results indicated that the can vacuum and can headspace were not affected by storage period and canning media. Values of lightness and hue decreased gradually in CPS canned in pineapple juice and heavy syrup when stored after 6 months. CPS in light syrup had the lowest h° compared to those in pineapple juice and heavy syrup. Flesh firmness of Standard and Choice

grades CPS showed sharp decreased after 6 and 12 months storage. Fancy grade showed a gradual decrease in flesh firmness throughout the storage period. Standard and Choice grades CPS canned in pineapple juice and heavy syrup had firmer flesh throughout the storage period compared to those in light syrup. Standard and Choice grades CPS showed sharp increases in soluble solids concentration (SSC) after 6 and 12 months storage. CPS in pineapple juice and heavy syrup showed gradual increased in SSC throughout the storage period. The percentage of β–carotene was highest in Standard grade CPS in heavy syrup, followed by pineapple juice and light syrup. Choice grade CPS canned in pineapple juice and heavy syrup showed higher percentages of β–carotene compared to those in light syrup, whereas Fancy grade CPS in light syrup showed the lowest percentage of β–carotene. β–carotene was positively and significantly correlated with L* and h° colour values indicating that CPS with high amount of β–carotene were lighter yellow. The results of this research can be used to develop the quality criteria of canned pineapples in the MSSCP so that the Malaysian canned pineapple can be more acceptable in the export markets.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

PENGARUH JANGKA MASA PENSTORAN DAN MEDIA PENGETINAN TERHADAP WARNA SERTA LAIN-LAIN CIRI KUALITI KEPINGAN NANAS (*ANANAS COMOSUS* L. MERR.) YANG TELAH DITINKAN

Oleh

JAYASHREE KANNIAH

Ogos 2002

Pengerusi : Profesor Madya Siti Hajar Ahmad, Ph.D.

Fakulti : Pertanian

Kesan jangkamasa penstoran dan media pengetinan ke atas nanas (*Ananas comosus* L. Merr) ditentukan. Nanas ditinkan pada suhu ambien selama 6 dan 12 bulan di mana 0 bulan adalah sebagai rawatan kawalan. Kepingan nanas ditinkan di dalam kandungan media, jus nanas, sirap pekat dan sirap cair. Kepingan nanas yang ditinkan adalah dari gred 'Standard', 'Choice' dan 'Fancy' seperti yang dinyatakan di dalam 'Malaysian Standard Specifications for Canned Pineapples'. Ujikaji ini dijalankan dengan menggunakan reka bentuk penuh rawak berblok dengan rawatan disusun secara faktorial (3 jangkamasa penstoran x 3 jenis media pengetinan) dan mengandungi 3 replikasi. Keputusan menunjukan bahawa vakum tin dan ruang kepala tin tidak dipengaruhi oleh jangkamasa penstoran dan media pengetinan. Nilai kecerahan dan 'hue' berkurangan secara beransur-ansur bagi kepingan nanas di

dalam media jus nanas dan sirap pekat selepas disimpan selama 6 bulan. Nanas di dalam sirap cair mempunyai nilai h° terendah berbanding dengan nanas di dalam jus dan sirap pekat. Kekerasan isi nanas gred Standard dan Choice menurun selepas disimpan selama 6 dan 12 bulan. Bagi nanas gred Fancy penurunan kekerasan adalah beransur-ansur mengikut jangkamasa simpanan. Dalam media jus nanas dan sirap pekat, kepingan nanas bagi gred Standard dan Choice adalah lebih keras berbanding dengan nanas dalam sirap cair. Gred Standard dan Choice menunjukkan peningkatan kepekatan keterlarutan pepejal yang mendadak selepas 6 dan 12 bulan disimpan. Nanas dalam jus dan sirap pekat menunjukkan kepekatan keterlarutan pepejal meningkat secara beransur-ansur mengikut jangkamasa simpanan. Peratus β–carotene adalah tinggi bagi gred Standard di dalam sirap pekat diikuti dengan jus nanas dan sirap cair. Gred Choice di dalam jus nanas dan sirap pekat mengandungi peratus β–carotene yang lebih tinggi dibandingkan dengan gred Choice di dalam sirap cair, sedangkan gred Fancy di dalam sirap cair mengandungi peratus β–carotene yang terendah. Korelasi bererti dan positif antara β–carotene dan nilai warna L* serta h° menandakan bahawa gred Standard dan Choice mengandungi kandungan β–carotene yang tinggi dan mempunyai warna kuning cerah. Keputusan kajian ini boleh digunakan untuk memperbaiki spesifikasi piawaian kriteria kualiti bagi nanas yang ditinkan untuk meningkatkan daya saing produk di pasaran eksport.

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My gratitude goes out to my parents and my siblings for their unconditional love and relentless support.

To GOD, for His gifts of wisdom, virtue and patience, but most of all, life.

Jayashree Kanniah

May 2002

I certify that an Examination Committee has met on 14th August 2002 to conduct the final examination of Jayashree Kanniah on her Master of Science thesis entitled "Colour and Other Related Quality Characteristics of Canned Pineapple (*Ananas comosus* L. Merr.) as Affected by Storage Period and Canning Media" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfillment of the degree of Master of Science. The members of the Supervisory Committee are as follows:

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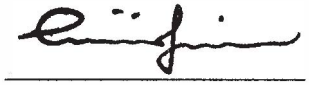

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

(JAYASHREE KANNIAH)
Date: 18.10.2002

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CHAPTER I

INTRODUCTION

The pineapple is a delicious fruit with a good source of vitamins A and C, which keeps body tissues strong, helps the body use iron and converts carbohydrates into energy and heat (Salunkhe and Desai, 1984). Pineapples contain an enzyme called bromelain. Bromelain helps the body's digestive system and it also has anti-inflammatory properties. It has been used to treat a number of medical problems, including heart disease, arthritis, and upper respiratory infections. When taken with antibiotics and chemotherapy drugs, bromelain has been found to increase the actions of these drugs (Salunkhe and Desai, 1984).

Canned pineapple is consumed throughout the world (Salunkhe and Desai, 1984). The highest grade is the skinned, cored fruit sliced crosswise and packed in syrup. Undersize or overripe fruits are cut into "spears", chunks or cubes. Surplus pineapple juice used to be discarded after extraction of bromelain. Today there is a growing demand for the juice as a beverage. Crushed pineapple juice, nectar, concentrate, marmalade and other preserves are commercially prepared from the flesh that remained attached to the skin after the cutting and trimming of the central cylinder. All residual parts including cores, skin and fruit ends are crushed and pressed for juice to be canned utilized in confectionery and beverages, or converted into powdered pineapple extract with various roles in the food industry (SIRIM, 1997). Pineapple can be consumed either fresh or in the

processed form, such as round cut, spiral cut slices, cubes and dices, chunks or segments, tidbits, salad cuts, broken slices, pieces, fingers or spears and crushed pineapple (SIRIM, 1997).

Today, pineapples are available fresh and canned almost worldwide. The canning operation is a mechanised work of art, beginning in the field where plants are bred for consistency in fruit size so that they fit in the canning machines (SIRIM, 1997). Canned pineapple is one of the most important fruit for export. Malaysia exports between 90-95% of its production to about 35-40 countries (MPIB, 1998). The Malaysian Pineapple Industry contributed a total of RM425 millions to the Malaysian Foreign Exchange earning for the period of 1991 to 1995. In 1996, Malaysia exported a total of 1,707,167 of canned pineapples, containing 34,152-metric tonnes of round cut pineapples valued at RM62.9 million. Malaysia's canned pineapple are well received in Japan (25.8%), U.S.A. (23.9%), Middle East (12.1%) and United Kingdom (10.9%) (MPIB, 1998). Therefore, improving and optimizing the quality of canned pineapple especially colour standard would increase demand by overseas market.

Colour is the most important factor in quality evaluation and product acceptability (Little, 1975) of canned pineapple mainly because the consumer buys with their eyes (Wilbur and Ronald, 1988). It affects consumer judgement of other sensory characteristics such as flavour, sweetness and saltiness as well as being an important predictor of non-sensory quality attributes like moisture content, over-processing and

pigment content. Fruit colour is used for determining the proper harvesting index and grade of pineapple to be canned (MPIB, 1996a).

Previously, the instrument used to determine the colour shade of pineapple flesh is the Lovibond Tintometer as cited in Malaysian Standard Specifications for Canned Pineapple (MSSCP) (SIRIM, 1975). The marks were awarded according to the three parameters (blue, yellow and red), which corresponds to 10 color shades. However, this instrument is difficult to use, no longer available and obsolete (Ahmad, 1996). So graders had to resort to visual evaluation because colour matching systems such as colour cards are not available and it is also the simplest and easiest way to evaluate colour (Wilbur and Ronald, 1988).

Grading of fruit, as determined by personal judgement and without the use of any other colour measuring instruments is often flawed. Personal judgements perceived through visual images are relative from one individual to another (Judd and Wyszecki, 1975). Visual evaluation could introduce bias in the grading system since the degree of error is often high (Voss, 1992). Visual accuracy of a person varies between age, sex and light intensity (Bollen *et al.*, 1993). Visual accuracy decreases with age, whereby a 60-year-old worker requires about twice the brightness level that a 20-year-old worker require for equal visual acuity (Luckiesh, 1964). Visual acuity decreases with age, but can be increased by increasing the brightness of the test object. Normal colour vision differs among sexes, whereby the degree of deviation from normal colour vision is 8% among males and 0.4%

among females (Judd and Wyszecki, 1975). Changes in the colour and intensity of light would change the image received by the eye. The ability of humans to perceive a visual image depends on both physical and cognitive factors (Prussia *et al*., 1991).

Colour can be evaluated by using instruments such as chroma meter and spectrophotometer or matching with the colour cards. Instruments such as the chroma meter can make it possible to determine flesh colour accurately because it is cheaper compared to the spectrophotometer (Voss, 1992). A spectrophotometer is very costly and most of the canneries could not afford it. The colour cards are made by taking pictures of the canned pineapple slices. This is done by a professional photographer with proper lighting. The coordinates, which are obtained from colour-measuring instruments, can be used to develop a colour chart for colour matching during grading of colour in canned pineapple. In the U.S.A. and E.E.C., the colour cards have been widely used in evaluating and describing colour (Mc Guire, 1992; Voss, 1992). With the colour card, grading of canned pineapple would be more efficient as the human eye is extremely sensitive to colour differences (Ahmad, 1996). There are also very limited skilled botanist and horticulturist, with deep knowledge of different numerical mathematical and three-dimensional geometric colour solid (Little, 1975; Francis, 1980).

Quality is important to ensure the end products meet the specification (Shewfelt and Prussia, 1993) and where the buyer can rely on a

certain minimum standard (Wills *et al.*, 1989). Quality attributes used in grading include flesh firmness, sugar content of the media and soluble solids concentration of the canned pineapple slices, headspace and vacuum of the can, would directly or indirectly affect the quality and acceptability of the product (Wilbur and Ronald, 1988). These quality attributes can be found in the MSSCP (SIRIM, 1975) but there is a need to keep abreast with the progress and new development in pineapple industry. Therefore, these quality attributes once made available for standardization, could be a useful guideline to enable the Malaysian canned pineapple to be more competitive in the export markets.

These quality characteristics could vary due to different type of grades, syrup content, cut of pineapple and can sizes. According to MSSCP (SIRIM, 1975), there are three types of grades, namely Fancy, Choice and Standard, packed in syrup that consists of water, natural pineapple juice (clarified or un clarified) and nutritive sweeteners, which helps to keep the texture firm and prevents the loss of colour. Changes in colour, flavour and texture are also affected by storage period (Lyon and Hulland, 1992). In view of the potential of canned pineapple for commercial production and export, there is a need to examine the affects of storage period and canning media on grades.

Therefore, the objectives of this experiment were to determine (a) the effects of storage period and canning media on flesh colour, firmness,

soluble solids concentration and syrup density and (b) the effects of canning media on β-carotene content of canned pineapples.

CHAPTER II

LITERATURE REVIEW

2.1 Pineapple

Pineapple was first discovered by Christopher Columbus on November 4, 1493 in the Island of Guadeloupe (Collins, 1960). Pineapple is a herbaceous perennial and native to tropical America. *Ananas comosus* (L.) Merr, or nanas in Malay, belongs to the family Bromeliaceae (Selamat, 1996). Some botanists treat *Ananas* as a monotypic genus with one monocarpic polymorphic species *A. comosus* Merr. Others choose to classify the pineapple into 2 genera, *Pseudoananas* and *Ananas* with the latter consisting of 5 *spp.*, namely *A. bracteatus*, *A. fritzmuelleri, A. comosus, A. erectifolius* and *A. ananassoides* (Teiwes, 1957).

The story of pineapple began in South America, where the fruit was already being cultivated and distributed at the time the Europeans first landed there. During the period from 1493 to 1900 many varieties of the pineapple species *Ananas comosus* were disseminated to various tropical countries around the world (Wahby and Ragab, 1969). In India and Malaysia, it has been cultivated since 1548 (Salunkhe and Desai, 1984).

Pineapple has strong spiny-serrate or spiny-tip leaves. The leaves are long and narrow, arranged in a spiral on a short stem, forming a rosette (Salunkhe and Desai, 1984). The fruit develops at the upper part of the

peduncle. It has an elongated or cylindrical fleshy body known as the 'pineapple' (Tay, 1981).

The pineapple is a perennial monocotyledonous plant having a terminal inflorescence and fruit, and continues growth after fruiting by means of one or more axillary buds growing into vegetative branches with a new apical meristem. Pineapples, grown in rows or individually, are planted from the suckers and tops. Suckers grow around the bottom of the mature plant during the fruiting season. They can be cut from the plant about one month after harvest. The suckers should be dried in the sun for one to two days before planting. They bear fruit about 12 months after planting. It is also possible to plant pineapple using the tops of the fruits. The tops are twisted off and planted. Eighteen months later they would bear fruits. Pineapple can be grown on practically any kind of soil provided they are not water logged or too clayey (Tay, 1974; Mohammed, 1996). Malaysia is the sole country in the world cultivating pineapple on peat soil (Asiah and Treptow, 1994) with pH ranging from 3.5 to 4.5 (Mohammed, 1996).

A. comosus (L.) Merr has been cultivated around the globe extending 30° in latitude north and south of the Equator (Collins, 1960). The temperature range in the pineapple growing areas of the world varies from 15 °C to 47 °C. The optimum temperature range for the crop is defined as between 23.9 °C to 29.4 °C (Shaari, 1981). The relative humidity is from 67% to 95% with mean monthly hours of bright sunshine at 220 hours and annual rainfall of 2200 mm to 3800 mm (Tay, 1970).

2.2 Types of Pineapple for Canning Purposes

In Malaysia, the strains of 'Singapore Spanish', 'Selangor Green', 'Mas Merah' and 'Gandol', are known as the canning cultivar (Tay, 1972). He also stated the origin of 'Singapore Spanish' is unknown. The colour of the peel at unripe stage is dark purple and the flesh is whitish. As ripening proceed the fruitlets turn from greenish yellow to yellow and then orange. The flesh changes from pale yellow to yellow, and then it becomes golden and remains opaque. The soluble solids concentration of 'Singapore Spanish' ranges from 10 to 15° Brix.

'Selangor Green' is also known as 'Selassie' (Tay, 1972). The colour of the peel of unripe fruit is dark green and the flesh is whitish. As ripening takes place, the flesh becomes yellow and move towards golden at the full ripe stage. The soluble solids concentration of 'Selangor Green' ranges from 9 to 16° Brix.

'Mas Merah' is a bigger fruit, varies in size between 0.45-2.0 kg, compared to 'Singapore Spanish' (Tay, 1981). The flesh colour at the unripe stage is pale yellow. The flesh becomes completely golden and translucent with further ripening. Generally the flesh begins to turn golden from the central area around the core and radiates outwards to the peel. The soluble solids concentration of 'Mas Merah' ranges from 8 to 16° Brix.

'Gandol' is also known as 'No.19' or 'Java Hybrid' from Selangor (Tay, 1972). The fruits are dark purple and consistently cylindrical with bulging eyes. The flesh is pale yellow at the unripe stage and turns golden and translucent as the fruitlet ripens. The soluble solids concentration of 'Gandol' is insipid, ranging from 8 to 15° Brix (Tay, 1972).

The 'Sarawak' is a dual-purpose fruit, suitable for canning as well as serving raw. The fruits are big (2-4 kg), green to copper in colour and fruit shape tends to be tapering. The 'Sarawak' tastes sweet with 14 to 17° Brix. The 'Sarawak' has no slips.

2.3 Processing of Canned Pineapple

The process of canned pineapple begins with canning, the most commonly used technique to heat-sterilize foods in order to prevent microbiological enzymatic spoilage. A variety of foods are canned, such as meats, fish, poultry, fruits and vegetables. Canning has proven to be one of the most effective techniques used for fruit preservation (Woodroof and Luh, 1986). In general, fruits are commodities with special organoleptic properties that must be carefully preserved. Factors such as colour, flavour and other quality attributes should be taken into consideration when establishing operating conditions for thermal processing especially in heat sensitive products such as delicate fruits and fruit juices (Woodroof and Luh, 1986).